NATIONAL BUREAU OF STANDARDS REPORT

3476

Color Characteristics of a Green Plastic
Developed by the Rohm and Haas Company for
Beacon Covers

by
F. C. Breckenridge

U. S. DEPARTMENT OF COMMERCE
NATIONAL BUREAU OF STANDARDS

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●Office of Basic Instrumentation

●Office of Weights and Measures.

NATIONAL BUREAU OF STANDARDS REPORT

NBS PROJECT		NBS REPORT
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Color Characteristics of a green Plastic Developed by the Rohm and Haas Company for Beacon Covers

by
F. C. Breckenridge

Photometry and Colorimetry Section
Optics and Metrology Division

Test No. 21A-7/53

Sponsored by
Office of Federal Airways
Civil Aeronautics Administration
Department of Commerce
Washington 25, D. C.

NBS

U. S. DEPARTMENT OF COMMERCE
NATIONAL BUREAU OF STANDARDS

Color Characteristics of a Green Plastic Developed by the Rohm and Haas Company for Beacon Covers

1. SCOPE

Early in 1952 the Office of Federal Airways informed this Bureau that it was experiencing difficulty in obtaining green cover glasses for beacons and requested that we cooperate with the Rohm and Haas Company in the development of a green plastic suitable for this use. This report summarizes the work done in response to that request, especially the testing of the initial order of green plastic cover plates.

2. PLASTICS TESTED

The initial request for this work was dated March 28, 1952 but by that date three samples had already been tested and informal reports made indicating that they were unsatisfactory. Subsequently, two written reports were submitted. covering these and other samples. Table I li ts the designations of the filters which have been tested and the report numbers.

TABLE I

Makers Sample No.	Samples Tested: Sample Received	N.B.S. Report No.	Findings
LPC-624A1-1 No. C-1610-A	Prior to 3-24-52	21A-6/52	Too low transmittance
Blue 606	3-26-52	21A-6/52	Too blue
Green 582	3-26-52	21A-6-52	Too yellow
LPC633A1-1 No. C-1679	4-30-52	21A-6/52	Promising but higher transmittance desired
LPC-633B1-1 No. C-1914	2-13-53	21A-3/53	Satisfactory for color, transmittance acceptable
Sample cover plate	5-22-53	21A-7/53	Acceptable, see conclusions

3. SOLAR HEAT TEST

Since many plastics soften at relatively moderate temperatures, it was thought possible that the sun's radiation, concentrated by a beacon reflector, might soften the plastic which could result in some distortion of the plate. To determine if there was any evident danger of this occurring in service, the green plastic plate which had been sent to this bureau was mounted in the bezel ring of a 24" drum-type rotating beacon and placed on a beacon on the roof of the East Building at the National Bureau of Standards. The beacon was faced in a direction to cause the image of the sun to fall on the plastic cover at the location which would apparently produce the greatest heating. To do this it was necessary to elevate the beacon at angles considerably above those to which it would be directed in service. When tests were being made in the afternoon angles of 35 to 45° were necessary. For a sunrise test an angle of 6° was used. The tests were continued throughout one afternoon and from sunrise until after 9:30 the following morning. The weather was clear and there was no wind blowing directly on the cover plate on either occasion. As the test was made early in June, the ambient temperature did not rise very high, but was about 75° Fahrenheit at the time the test was started.

At no time was any softening of the plastic detected. The temperature of the plastic, when touched, was not hot enough to cause any serious discomfort, and when the test had been completed, visual examination of the plate revealed no deterioration in any respect.

4. INITIAL CHROMATICITY

As it was impracticable to make spectrophotometric measurements on the entire disc, a 2-inch circle was cut from the center of it for such measurements. The hole left by this circle was filled with a piece of clear plastic cemented into the cover plate and the cover plate was then returned to the Office of Federal Airways so that it could be included in the field tests.

Measurements of spectral transmittance were made on a General Electric recording spectrophotometer equipped with slits equivalent to approximately 10 millimicrons of spectrum for the visible region, 400 to 750 millimicrons. A second measurement of spectral transmittance was made in each case with the sample oriented 90° from the first position. The spectrophotometric curves were read at each 10 millimicron interval making corrections for 100%, zero, and wavelength errors.

The chromaticity of the light transmitted by the cover plate has been computed for sources of color temperature 1500°K, 1900°K, 2350°K, 2850°K, and 3000°K. These computations were made for the C.I.E. coordinates and the results have been transformed into R-U-C-S coordinates. The values in both systems of coordinates are given in Table II along with the transmittance as computed from the spectrophotometric measurements. These values have also been plotted in Figures 1 and 2 which show the relationship of the chromaticities to the boundaries of both Specification ANC-56 and Federal Standard No. 3 in the C.I.E. and R-U-C-S coordinate systems. The chromaticities of the earlier samples are shown in Figure 2, Test 21A-6/52 and Figure 2, Test 21A-3/53, which have been incorporated into this report.

5. ACCELERATED WEATHERING TEST

Accelerated weathering tests were made on the green plastic disk described above. The tests were conducted in accordance with Federal Specification L-P-406a for 4 periods of 120 hours each, totaling 480 hours. After each interval of weathering, the sample was spectrophotometered and its chromaticity and transmittance were computed. These values are given in Table II. They are not shown in the diagrams as the differences are not significant.

TABLE II

Specimen Samples	Weathering (Hrs.)	Color Temp.	Transmittance	C.I.E. x	C.I.E. y	R-U-C-S x''	R-U-C-S y''
LPC624A1-1	None	3100	0.056	0.084	0.625	+0.035	+0.209
Blue 606	"	"	0.109	0.116	0.328	-0.044	+0.179
Green 582	"	"	0.128	0.188	0.671	+0.056	+0.160
LPC633A1-1	"	"	0.196	0.177	0.562	+0.035	+0.157
LPC633B1-1	"	1900	0.145	0.207	0.557	+0.039	+0.140
"	"	2350	0.180	0.185	0.512	+0.026	+0.148
"	"	2850	0.208	0.172	0.428	+0.014	+0.152
"	"	3100	0.219	0.167	0.456	+0.009	+0.154
2" Disk*	"	1500	0.103	0.235	0.604	+0.052	+0.130
"	"	1900	0.142	0.204	0.564	+0.040	+0.142
"	"	2350	0.176	0.184	0.520	+0.027	+0.150
"	"	2850	0.203	0.170	0.482	+0.016	+0.154
"	"	3000	0.210	0.168	0.472	+0.013	+0.155
"	120	"	0.209	0.167	0.470		
"	240	"	0.208	0.167	0.480		
"	360	"	0.204	0.164	0.467		
"	480	"	0.207	0.167	0.472		

* Cut from beacon cover

6. CONCLUSIONS

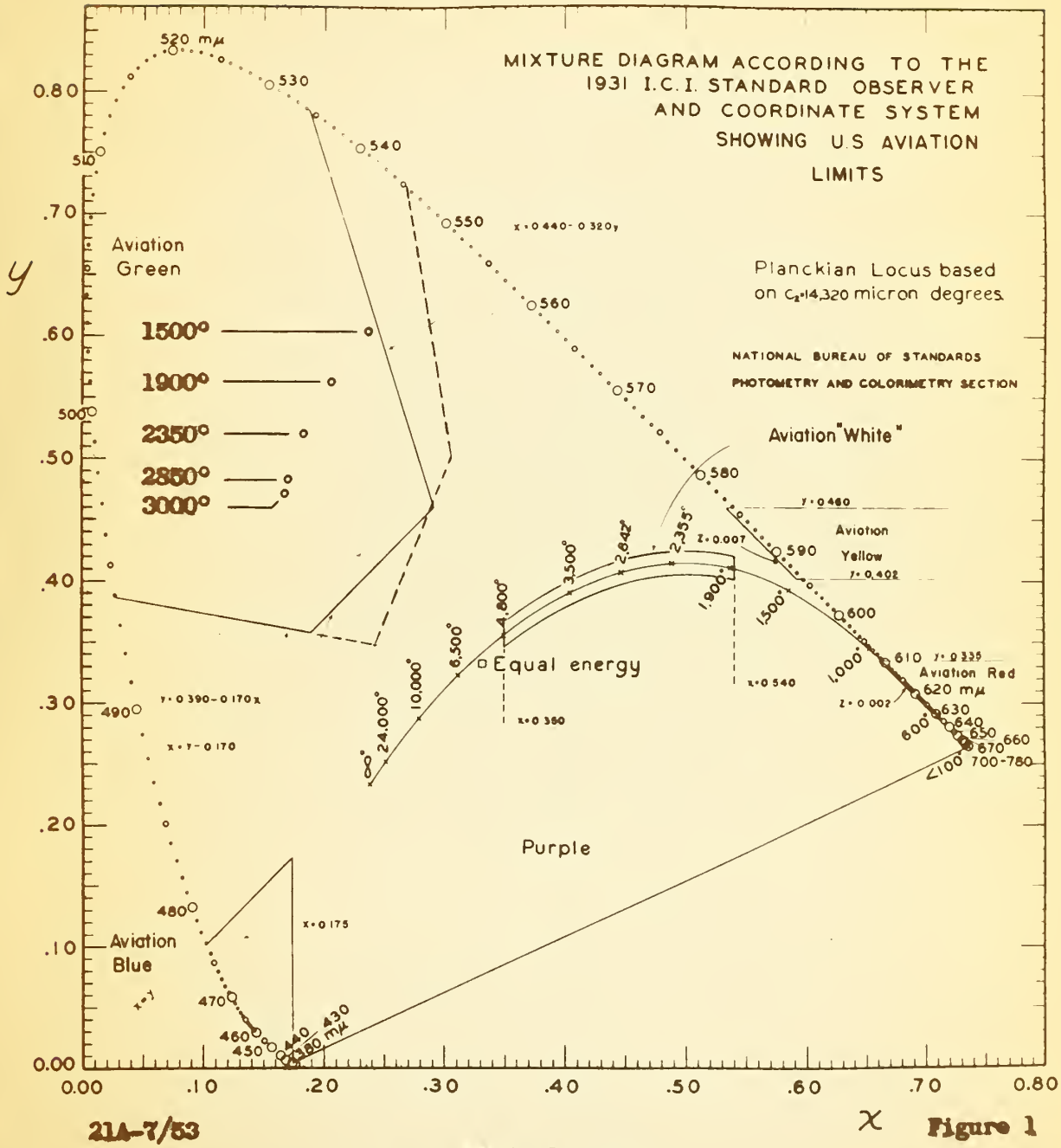
All the tests made on the specimen representing the cover plate have given satisfactory results indicating, so far as it is possible to learn from these tests, that the plastic cover plates should be satisfactory in service with respect to initial color, variation of color with light source temperature, resistance to changes of color with weathering, and softening due to the reflection of sunlight from the beacon reflector.

Table II shows a small change in chromaticity after the 360 hours of accelerated weathering. While this color change might be detectable on visual comparison of two samples of plastic, it is not sufficient to be detected in the color of the beacon flash. While no explanation is known for this variation in the numerical results, it is not considered significant.

Although not tested in the present case, the abrasion resistance of plastics is a characteristic which needs to be considered in determining whether or not this type of material can be used for a specific application. The service tests now going on should yield some information with reference to the limitations of this type of plastic from the standpoint of abrasion deterioration. If no difficulty is experienced from abrasion, an analysis should be made to learn if it would be economically practicable to use plastics for some other types of aviation lighting equipment. Plastics can be molded more accurately than glass which may make it possible to design plastic units which are physically smaller than the corresponding glass units and still maintain the candlepower of the units. This may be important in keeping the overall cost of an installation of plastic units comparable to that of other types now in use.

Other considerations favoring the use of plastic units for runway and taxiway lighting are the lightness of the material and the fracturing characteristics both of which could make plastic units less hazardous than glass units to aircraft when a unit is struck by the wheel of a fast moving airplane.

Green Plastic Beacon Cover Plate
Furnished by Rohm & Haas Co.
Chromaticity of Signal for Lamps of
Indicated Color Temperatures

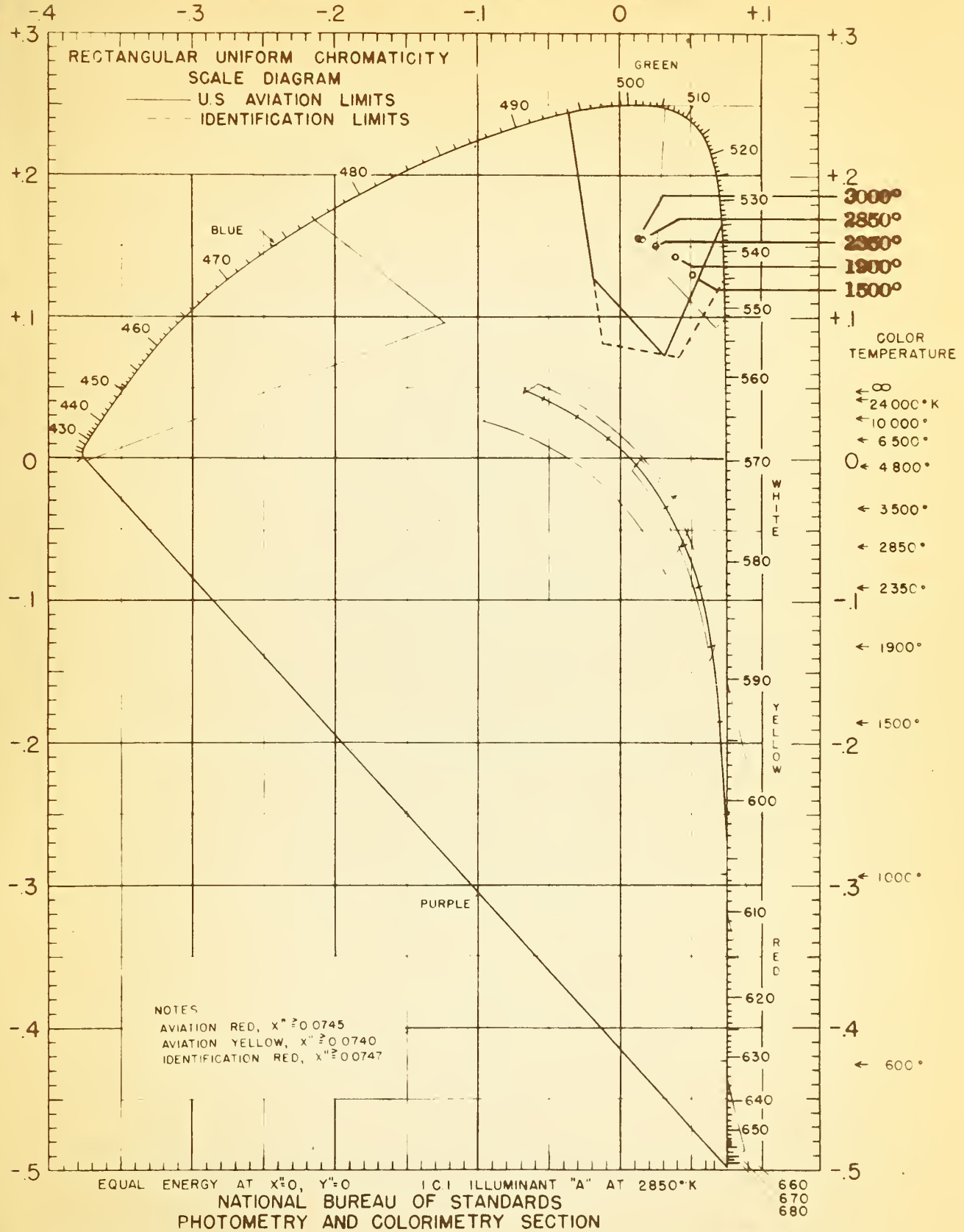


21A-7/53

Figure 1

AN-C-56 ——
Fed.Std.No. 3 – – –

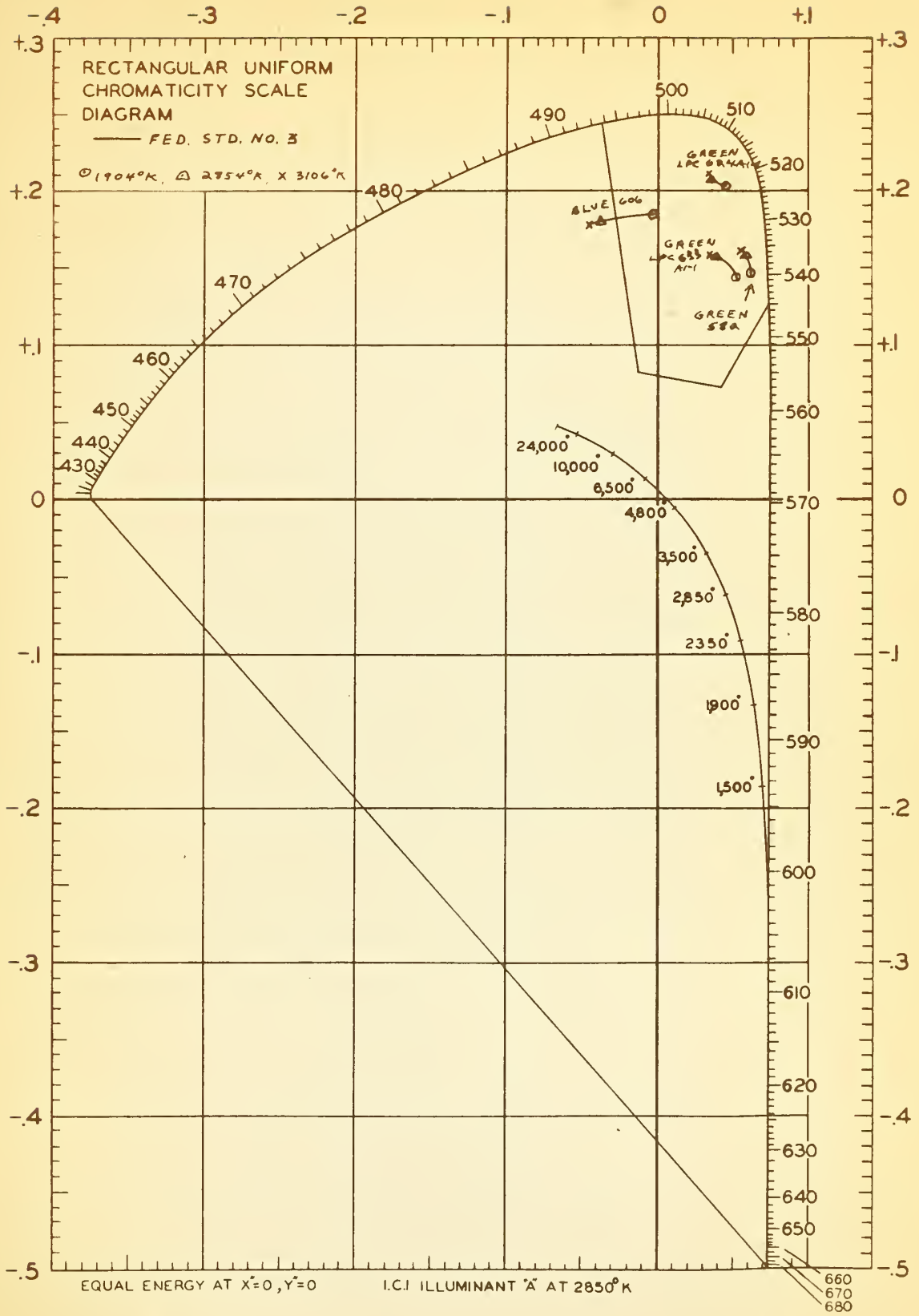
Green Plastic - Rohm & Haas
Chromaticity vs Color Temperature of Source



21A-7/53

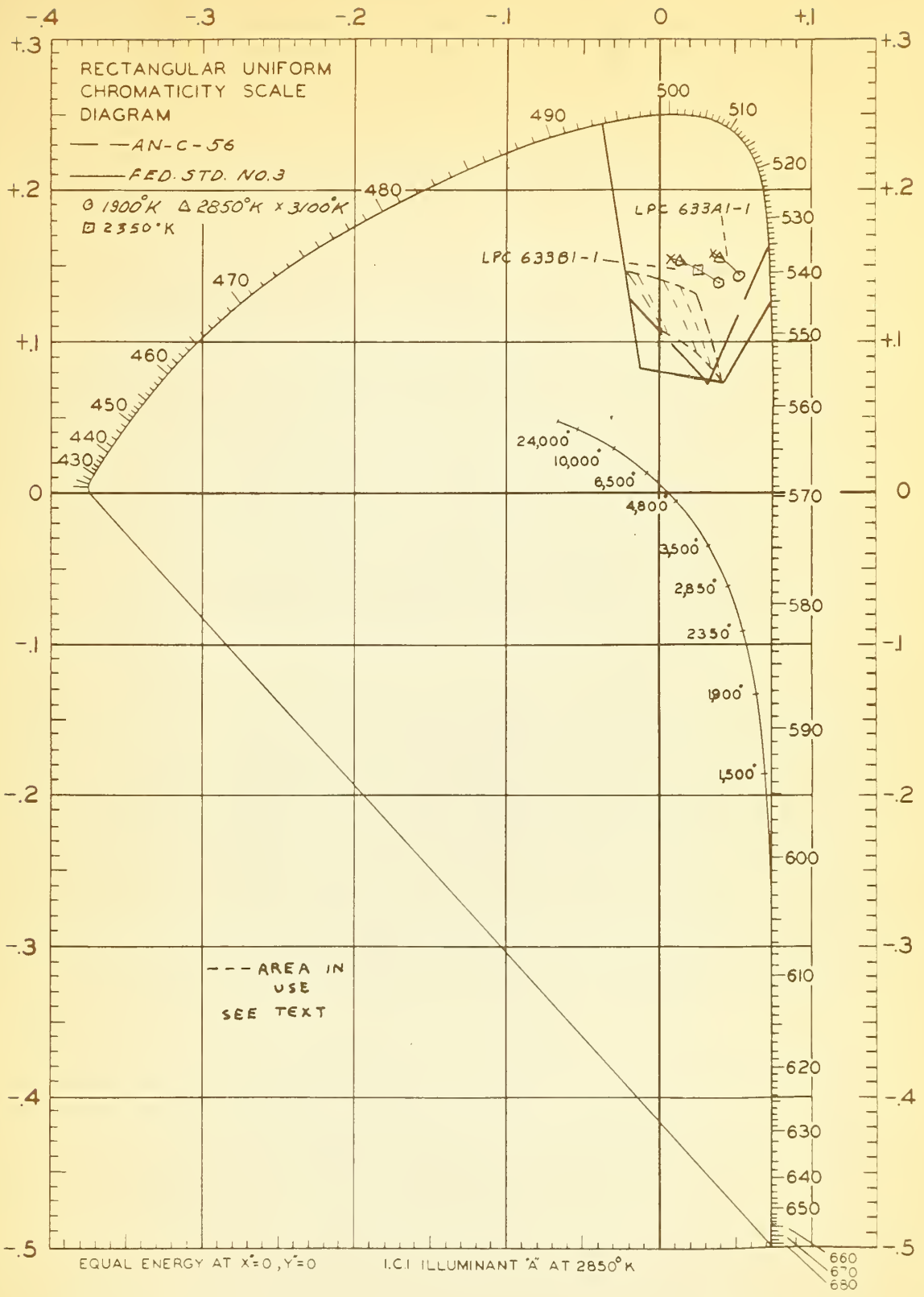
Figure 2

AN-C-56 ——
Fed. Std. No.3 – – –



NBS. TEST NO. 21A-6/52

FIGURE 2



NBS TEST NO. 21A - 3/53

FIGURE 2

THE NATIONAL BUREAU OF STANDARDS

Functions and Activities

The functions of the National Bureau of Standards are set forth in the Act of Congress, March 3, 1901, as amended by Congress in Public Law 619, 1950. These include the development and maintenance of the national standards of measurement and the provision of means and methods for making measurements consistent with these standards; the determination of physical constants and properties of materials; the development of methods and instruments for testing materials, devices, and structures; advisory services to Government Agencies on scientific and technical problems; invention and development of devices to serve special needs of the Government; and the development of standard practices, codes, and specifications. The work includes basic and applied research, development, engineering, instrumentation, testing, evaluation, calibration services, and various consultation and information services. A major portion of the Bureau's work is performed for other Government Agencies, particularly the Department of Defense and the Atomic Energy Commission. The scope of activities is suggested by the listing of divisions and sections on the inside of the front cover.

Reports and Publications

The results of the Bureau's work take the form of either actual equipment and devices or published papers and reports. Reports are issued to the sponsoring agency of a particular project or program. Published papers appear either in the Bureau's own series of publications or in the journals of professional and scientific societies. The Bureau itself publishes three monthly periodicals, available from the Government Printing Office: The Journal of Research, which presents complete papers reporting technical investigations; the Technical News Bulletin, which presents summary and preliminary reports on work in progress; and Basic Radio Propagation Predictions, which provides data for determining the best frequencies to use for radio communications throughout the world. There are also five series of nonperiodical publications: The Applied Mathematics Series, Circulars, Handbooks, Building Materials and Structures Reports, and Miscellaneous Publications.

Information on the Bureau's publications can be found in NBS Circular 460, Publications of the National Bureau of Standards ($1.00). Information on calibration services and fees can be found in NBS Circular 483, Testing by the National Bureau of Standards (25 cents). Both are available from the Government Printing Office. Inquiries regarding the Bureau's reports and publications should be addressed to the Office of Scientific Publications, National Bureau of Standards, Washington 25, D. C.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